

CLAIMS

1. A method of reducing latency in a data-over-cable system having a cable modem termination system and a cable modem in communication with each other over a cable network, comprising the steps of:

5 (a) transmitting data associated with either (i) packet arrival times or (ii) latency between grants of bandwidth and packet arrival times from a cable modem to a cable modem termination system; and

(b) transmitting from said cable modem termination system grants of bandwidth in an upstream direction to said cable modem at intervals derived from said data in step (a), wherein said grants of bandwidth are timed to arrive simultaneously with or shortly after arrival of additional packets at said cable modem for transmission to said cable modem termination system.

2. The method of claim 1, further comprising the step of (c) transmitting Transmission Control Protocol acknowledgment packets from said cable modem to said cable modem termination system in response to said grants of bandwidth.

3. The method of claim 1, further comprising the step of (c) transmitting voice packets from said cable modem to said cable modem termination system in response to said grants of bandwidth.

4. The method of claim 1, wherein the data transmitted in step (a) comprises a time stamp indicating the arrival time of a packet at said cable modem.

5. The method of claim 4, wherein said time stamp is synchronized with a DOCSIS system clock.

6. The method of claim 1, wherein said data transmitted in (a) is transmitted in an extended header in a DOCSIS MAC header.

7. The method of claim 1, wherein said data in step (a) comprises a report indicating the arrival times of a number of packets at said cable modem for transmission to said cable modem termination system.

8. The method of claim 1, wherein said data in step (a) comprises a report indicating the amount of latency for at least one packet arriving at said cable modem for transmission to said cable modem termination system.

9. The method of claim 1, wherein said data in step (a) is stored in a managed object at the cable modem and accessed by said cable modem termination system.

10. The method of claim 1, further comprising the step of adjusting a nominal grant interval boundary by an amount indicated by the data in step (a) so as to time the arrival of grants

of bandwidth at said cable modem with the arrival of a packet at said cable modem for transmission to said cable modem termination system.

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In a data-over-cable system, a method for minimizing accumulation of TCP ACK packets at a cable modem, comprising the steps of:

- d) said cable modem time stamping the arrival of TCP ACK packets from an end station connected to said cable modem;
- e) transmitting one or more packets from said cable modem to a cable modem termination system containing data associated with a plurality of said time stamps;
- f) said cable modem termination system obtaining from said time stamps a periodicity of TCP ACK packets arriving at said cable modem and responsively conducting a grant of bandwidth service for said cable modem based on said periodicity for transmission of said TCP ACK packets to said cable modem termination system.

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The method of claim 12, wherein said data in step b) is transmitted in an extended header of a DOCSIS MAC header.

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14. The method of claim 12, wherein said time stamp is made in accordance with a DOCSIS system clock.

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15. In a data-over-cable system, a method for minimizing accumulation of TCP ACK packets at a cable modem, comprising the steps of:

- a) said cable modem time determining the latency between the arrival of TCP ACK packets from an end station connected to said cable modem and grants of bandwidth from a cable modem termination system;
- b) transmitting one or more packets from said cable modem to a cable modem termination system containing data associated with said determination of latency; and
- c) said cable modem termination system responsively conducting a grant of bandwidth service for said cable modem based on said latency for transmission of said TCP ACK packets to said cable modem termination system.

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16. In a cable modem having a memory, the improvement comprising:
software or hardware apparatus recording in said memory the time at which packets
arrive at said cable modem from an end station connected to said cable modem; and
communications apparatus including software in said cable modem forwarding said time
recorded in said memory to a cable modem termination system.

17. The improvement of claim 16, wherein said cable modem observes a DOCSIS
system clock and wherein said recording in said memory of the time comprises a recording of
said time in accordance with said DOCSIS system clock.

18. In a cable modem having a memory, the improvement comprising:

software or hardware apparatus recording in said memory the latency between time of arrival of packets at said cable modem from an end station connected to said cable modem and the grants of bandwidth for forwarding said packets to said cable modem termination system; and

communications apparatus including software in said cable modem either forwarding or making available to said cable modem termination system data associated with said latency.

19. The improvement of claim 18, wherein said packets comprise TCP acknowledgment packets.

20. The improvement of claim 18, wherein said packets comprise voice packets.

21. The improvement of claim 18, wherein said voice packets are coded by a G.711 CODEC.

21. In a cable modem termination system transmitting grants of bandwidth in an upstream direction to cable modems during a nominal grant interval boundary, the improvement comprising:

software responsive to information as to latency between arrival of packets at said cable modem and previous grants of bandwidth and responsively adjusting the timing of the nominal grant interval boundary to thereby time the arrival of grants of bandwidth so as

to arrive simultaneous with or shortly after the arrival of packets at said cable modem from and end station connected to said cable modem.

22. The improvement of claim 21, wherein said packets comprise voice packets.
23. A method of decreasing latency in a Voice over Internet Protocol (VoIP) session between a cable modem and a cable modem termination system, said cable modem termination system periodically transmitting grants of bandwidth during a nominal grant interval having a boundary in time commencing said nominal grant interval, the method comprising the steps of:
 - d) determining the latency L between a nominal interval grant boundary and the arrival of a voice packet at said cable modem;
 - e) said cable modem termination system determining said latency L ; and
 - f) said cable modem termination system shifting said nominal interval grant boundary an amount equal to L .
24. The method of claim 23, wherein step b) comprises the step of transmitting data from said cable modem to said cable modem termination system identifying said latency L .
25. The method of claim 23, wherein step b) comprises the step of transmitting reports to said cable modem termination system indicating said latency L for a plurality of packets.

26. The method of claim 25, wherein step b) comprises maintaining a managed object at said cable modem storing information as to said latency and said cable modem termination system accessing said managed object.

27. The method of claim 23, wherein step b) comprises forwarding packet arrival times to said cable modem termination system.